

MESOZOIC INSECTS OF QUEENSLAND.

No.3. ODONATA AND PROTODONATA.

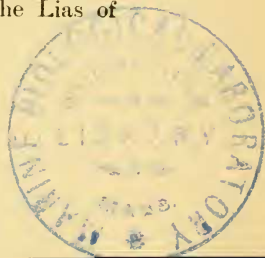
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(Plates xlv.-xlv., and Text-figures 11-16).

Since the publication of No.2 of this Series(4), Mr. Dunstan has completed the delamination of the rock taken from the Ipswich Fossil Bed, in the course of gathering together the material forming the *third* collection(3) of these fine fossils. The whole of this collection, with the single exception of the Coleopterous elytra, is now in my hands for study. Amongst the very fine material received in the last consignment are two interesting fossil Odonata, these being the only Dragonflies found at Ipswich since the discovery of *Mesophlebia antinodalis* Till., described in a former paper(2).

The former consignment also contained a very fine fossil, which is of such unique structure that it is not easy to place it in any of the accepted Orders, either fossil or recent. This fossil has been studied by me for a long time; and I have definitely concluded that it is best placed in the Protodonata, of which it must form a new Suborder. The present paper deals with this fossil and the two Dragonflies above-mentioned.

Recently, Dr. A. B. Walkom, of the University of Queensland, Brisbane, has published his thesis upon the Lower Mesozoic Rocks of Queensland(5), in which he discusses very fully the age of the Ipswich Beds. There can be very little doubt that his placing of these beds as Upper Triassic is correct, and as such I am content to accept them. It will be more and more evident, as the description of the fossil insects proceeds, that they consist of a definitely Mesozoic Fauna, not unlike that of the Lias of



England, together with a number of older forms, apparently relies of the old Carboniferous Fauna, such as we know from Commeny in France. The three insects described in this Part illustrate this intermingling of forms very clearly.

Order **ODONATA**.

Suborder **Zygoptera**.

Family **LESTIDÆ**.

Subfamily **TRIASSOLESTINÆ**, n.subfam.

Wings with the bases strongly reduced, petiolate; the whole of the area between Cu and the posterior margin, below the quadrilateral, free of veins; and, hence, no anal bridge present. Quadrilateral narrow, placed very obliquely to the long axis of the wing; its upper side short, its lower long, and hence its distal angle very acute; Cu₁ and Cu₂ arising together from this angle. Arculus complete, with M_{1,3} arising from the top of the quadrilateral.

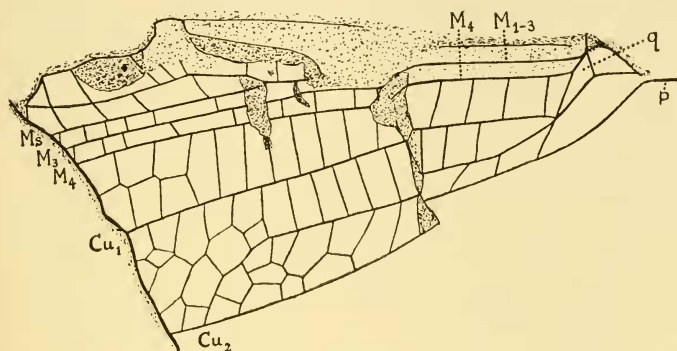
Genus **TRIASSOLESTES**, n.g. (Text-figs. 11, 12*b*).

A complete antenodal cross-vein in line with the arculus; (this is probably the second of the series). Distal side of quadrilateral continued straight to the posterior border of the wing, by an oblique cross-vein. M_{1,3} arching slightly upward as each branch is given off; M₃ arises about six cells distad from the level of the quadrilateral; Ms arises from M_{1,2} about four cells further distad than M₃. Discoidal field fairly wide, with M₄ and Cu₁ slightly divergent; a single row of cells to beyond the level of the origin of Ms, followed further distad by two rows. Between Cu₁ and Cu₂, a single row of cells at first, to about level of origin of Ms. Cu₂ curves strongly downwards distally to meet the posterior border of the wing; between it and the wing-border, one row of cells basally, increasing to two distally. [Anterior and distal portions of the wing missing, including nodus and pterostigma].

Genotype, *Triassolestes epiophlebioides*, n.sp. (Upper Triassic, Ipswich, Queensland).

TRIASSOLESTES EPIOPHLEBIOIDES, n.sp. (Text-figs. 11, 12b).

A well-preserved fragment, 18.5 mm. long, greatest width (distally) 8.5 mm.; consisting of the greater portion of the basal half of the wing, but without the extreme base. The anterior part, including the costa, subcosta, and radius, missing. The preserved portion includes the quadrilateral, the media and cubitus with their branches, and the posterior border of the wing. The anal vein appears to be completely fused with the latter.



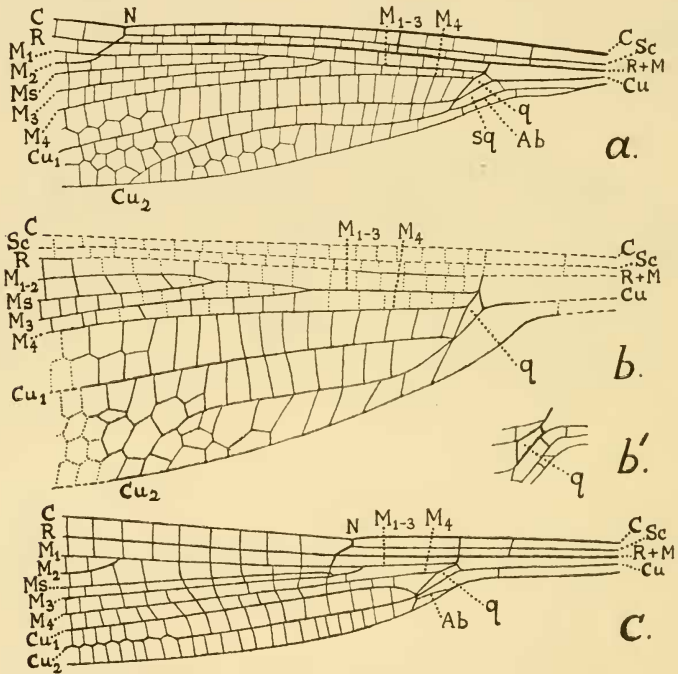
Text-fig. 11.

Triassolestes epiophlebioides, n.g. et sp., (Triassic, Ipswich, Q.). preserved portion of wing; ($\times 5$). Cu_1 , Cu_2 , branches of cubitus; M_{1-3} , upper, and M_4 , lower sector of arculus; Ms , Zygopterid sector; p , petiole; q , quadrilateral.

The appearance of the fossil may be seen from Text-fig. 11. The veins are all beautifully preserved, but unfortunately the wing lies upon some plant-remains, which appear to have been hard twigs or stems, and which have caused the fossil to rest upon a very uneven surface; with the result that, in one place at least, the wing has become crumpled or torn transversely, so that the continuity of the main veins is badly broken. The veins can, however, be followed across the break, and picked up on the other side of it. Distally also, in the region of M_{1-2} , the wing lies upon an uneven surface, and the position of both main veins and cross-veins is somewhat distorted.

Eliminating the effect of these inequalities, it is not a difficult

task to restore the wing to its correct form, as far as it is preserved for us. The result is to be seen in Text-fig.12*b*, to which I have added the probable courses of the veins that are missing in the fossil. For purposes of comparison, I have shown also the



Text-fig.12.

(a) *Epiophlebia superstes* (Selys), (Recent, Japan), forewing; *b'*, region of quadrilateral of hindwing of same. (b) *Triassoletes epiophlebioides*, n.g. et sp., (Triassic, Ipswich, Q.), restored wing, with missing parts shown by dotted lines. (c) *Synlestes weyersi* Selys, (Recent, Australia), forewing. The basal portions of all three wings shown for comparison with one another, (all $\times 4$). Ab, anal bridge; C, costa; N, nodus; R, radius; sq, subquadrangle. Rest of lettering as in Text-fig.11.

corresponding areas of the forewings of *Epiophlebia superstes* (Selys), and *Synlestes weyersi* Selys, both of which show certain points of resemblance with this interesting new fossil.

Comparing the fossil first of all with *Epiophlebia*, we note that

the fossil wing was considerably broader, and probably also somewhat longer. The region of the quadrilateral is closely similar in both, but the quadrilateral of the fossil wing is placed more transversely to the wing-axis, and the lower portion of the arculus is much more transversely placed than in *Epiophlebia*. The quadrilateral of the fossil resembles that of the forewing of *Epiophlebia* (Text-fig.12a) much more than it does that of the hindwing (*b'*); but, in other respects, particularly in the strong distal curvature of Cu_2 , the fossil wing more resembles the hindwing. A close resemblance to *Epiophlebia* is shown in the levels of the origins of the branches of M , and in the shape and venation of the discoidal field and the two longitudinal areas of the wing lying below it.

The fossil, however, differs entirely from *Epiophlebia*, and, indeed, from all known *Lestidae*, in possessing a broad and absolutely free area between Cu and the posterior border, below the quadrilateral. As the wing is excellently preserved in this region, there can be no doubt about this character, which places the fossil, in this respect, as more highly specialised by reduction than any known *Zygoptera*, except only the subfamily *Protoneurinae* of the family *Agrionidae*.

Where the nodus was placed, we cannot tell for certain. But, if we were agreed that the comparison with *Epiophlebia* would hold also for this character, we might expect that it was situated somewhere near the extreme distally preserved portion of the fossil, *i.e.*, considerably distad from the level of the origin of Ms .

The comparison with *Synlestes* is by no means so close, as can be seen from Text-fig.12c. The wing of *Synlestes* is exceedingly narrow, and differs from that of the fossil in having Ms arising from M_3 close to its origin, in the very narrow quadrilateral, in the upward arching of Cu_1 from the distal angle of the quadrilateral, in the consequent narrowing of the discoidal field, and in the length and straightness of Cu . But, in its extreme reduction of the anal bridge (*Ab*), *Synlestes* shows the nearest existing approach to the high specialisation seen in the fossil; and, on this account, the comparison is of value.

While placing this fossil as more closely allied to *Epiophlebia* than to any known Dragonfly, fossil or recent, it seems to me that the characters exhibited by it require its elevation to subfamily rank. But, if the area below the quadrilateral had possessed an anal bridge, I should have been content to place it in the subfamily *Epiophlebiinae*.

The Lestid affinities of the fossil appear to me to be beyond doubt. As it appears that some students of the Odonata have been unwilling to accept my removal of *Epiophlebia* to the family *Lestidae*, I should now like to draw their attention to this fossil, which was unknown at the time that I made this suggestion. The combination of Epiophlebiine characters from the quadrilateral distad, with the extreme reduction of the base, which characterises this fossil, should surely be regarded as a further link in the chain of evidence for the Lestid affinities of *Epiophlebia*.

Type, Specimen No. 205a, (Coll. Queensland Geological Survey).

Horizon: Upper Triassic, Ipswich, Q.

ODONATA INCERTÆ SEDIS.

Genus PERISSOPHLEBIA, n.g. (Text-fig. 13).

Between C and R, beyond pterostigma, an irregular double row of cells. Between R and M_1 , beyond level of pterostigma, at first an irregular triple row of cells, followed by a more regular double row. Below M_1 , a strong convex sector is developed towards the apex of the wing, three rows of cellules from it. This is probably M_{1A} . Close below this sector, and only a single row of cells' width from it, there is a parallel concave sector. Both the above sectors converge towards M_1 as they approach the apex of the wing. Some three or four rows of cells below the concave sector, there is a diverging convex sector, which is probably M_2 .

[Only a fragment of the wing is preserved, embracing a portion beyond the pterostigma].

Genotype, *Perissophlebia multiseriata*, n.sp. (Upper Triassic, Ipswich, Q.).

So little of the wing of this fine Dragonfly is preserved, that it would be inadvisable to name it, were it not for the very remarkable characters exhibited by the preserved portion of the wing. It may be stated as a general rule, both for recent and fossil Odonata, that the spaces between C and R, on the one hand, and between R and M_1 , on the other, from the level of the pterostigma to the apex of the wing, are only filled by a single row of cells. As exceptions to this, we may note the Liassic genus *Petrothemis* Handl., in which the distal portion of the space between C and R is filled with three rows of minute cells, and the basal portion of the space between R and M_1 carries two rows of cells near the pterostigma, decreasing to one row only towards the apex; and the very densely-veined *Aeschnidiidae*, in which the upper of the two spaces in question has only one row of cells, but the lower has two.

Hence we see that, on this character alone, *Perissophlebia* stands as the most densely veined of all known Odonata.

A second character, that is very exceptional in Odonata, is the arrangement and direction of the longitudinal veins lying below M_1 . These are so strongly developed that they would appear, at first sight, to be portions of main veins. But a little consideration of the position of the pterostigma shows us that the preserved portion of the wing represents only a very small piece of a very large wing. The lowest of the three sectors seen below M_1 in the fossil is concave, and may very probably be M_2 ; the other two are almost certainly not branches of M, but intercalated sectors. Of these latter, the upper one, being strongly convex, very probably corresponds with the *postnodal sector*, M_{1A} , found in recent Zygoptera and in *Petalura*; while that below it might be either a concave supporting sector, or a branch from M_2 itself. In any case, the directions of these three veins, two being parallel to one another but converging towards M_1 distally, and the third being parallel to M_1 , are quite exceptional in the Odonata.

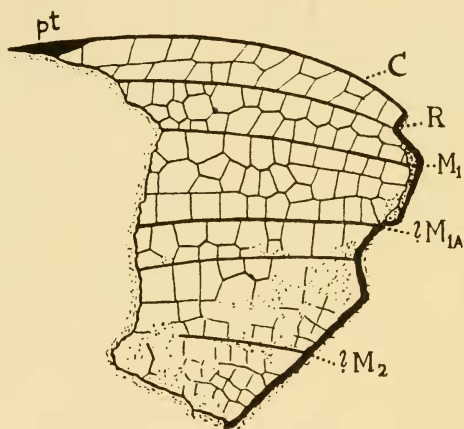
It is clear then that, in spite of the small amount of the wing preserved, the characters there shown are quite marked enough to warrant the giving of a name to the fossil.

PERISSOPHLEBIA MULTISERIATA, n.sp. (Text-fig.13).

Total length of fragment, 8.5 mm.; greatest breadth of same, 8.5 mm.

A small portion of the pterostigma preserved appears to point definitely to the fact that it was sharply angulated at its upper distal angle; a character that is exceptional amongst fossil Odonata.

Most of the fragment is very well preserved, with the cross-veins clearly visible; but, in the lower portion, they are partly obliterated.



Text-fig. 13.

Perissophlebia multiseriata, n.g. et sp., (Triassic, Ipswich, Q.). Preserved portion of wing, ($\times 7\frac{1}{2}$). M_1 , postnodal sector.

The distance from the tip of the pterostigma to the apex of the wing, and the great width of the wing beyond the level of the pterostigma, both point to the fact that it is a fragment of a very large wing, probably as large as, or larger than, that of *Petalura gigantea* Leach.

Type, Specimen No.203 *a-b* (part and counterpart). (Coll. Queensland Geological Survey).

It is impossible to place this fragment definitely; but I would

suggest a likely relationship with *Petrothemis singularis* Handlirsch, which is itself unplaced, owing to absence of the basal half of the wing. A figure of this latter fossil is given in Handlirsch's Atlas(1), Plate xlii., fig.9. It is a much smaller wing than that of *Perissophlebia*, and comes from the Upper Lias of Dobbertin, Mecklenberg.

Order **PROTODONATA.**

Suborder **Aeroplanoptera**, subordo nova.

Insects with strongly veined wings, traversed by numerous parallel longitudinal veins, with a network of irregular cross-veins, well developed near the base only; in the rest of the wing, the cross-veins tend to become weak, and almost disappear distally. Costal border strongly developed, coriaceous at base. Radius with a single sector. Media with many dichotomous branches. Cubitus two-branched.

This Suborder is at once distinguished from all the rest of the Protodonata (which may be termed the Suborder Meganeuroptera, from the dominant family) by the close, parallel veining of the wings, the dichotomous branchings of the media, and the two-branched cubitus. In this latter character, it agrees with the Order Odonata; whereas the rest of the Protodonata have only a simple cubitus.

Family **AEROPLANIDÆ**, fam.nov.

Wings excessively elongated and narrow, the parallel longitudinal veins strongly developed and close together. Subcosta weak, in a deep groove just in front of the exceedingly strongly developed radius. The single radial sector arising from near the base *by a double root*. Media seven-branched in both wings, but the method of branching is different in fore- and hindwings. Radius and media just fused at bases. Cubitus with its two branches arising close to the base and diverging gradually. A single anal vein present, below which is developed an anal field with irregular veining, supported by a curved recurrent supplement.

Genus *AEROPLANA*, n.g. (Plates xlv.-xlv., Text-figs. 14, 15).

Characters of the family, with the following additions. First and second origins of Rs arising not far apart, the portion between them somewhat curved concavely to R. First dichotomy of M at same level as first origin of Rs. In forewing, the anterior branch of M gives rise to three branches, by two dichotomies which take place at some distance from the first; the posterior branch also gives rise to three branches, which arise much closer to the original forking. The middle of these three last branches forks again, a little further distad. Thus there are seven branches in all, three arising from the anterior branch, and four from the posterior. In the hindwing, the anterior branch of M remains simple for a considerable distance, but finally divides into two only; the posterior branch, on the other hand, soon divides again into two, of which the upper branch gives rise to three branches by two separate dichotomies, the lower to two only. Thus there are also seven branches of M in the hindwing, but of these only two arise from the anterior branch, and five from the posterior.

The two branches of Cu diverge very slightly from one another at first, both tending to diverge also from the radius, in the same manner that the media does. A little further distad, close to the level of the first origin of Rs, Cu₂ begins to curve strongly away from Cu₁, forming a wide bend, and later on again approaches Cu₁, to run parallel to and beneath it.

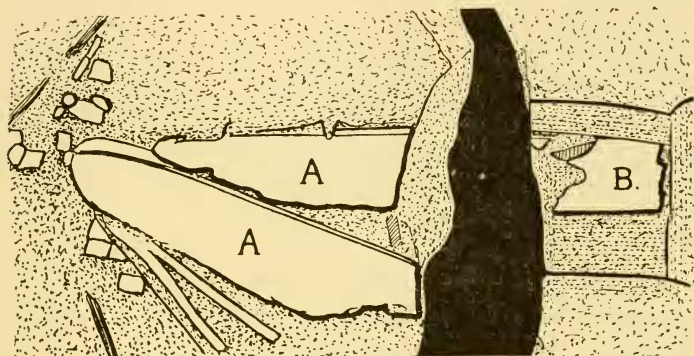
Just distad from the first dichotomy of M, in the hindwing only, a weak, curved supplement runs back obliquely to join Cu₁, resembling in form the anal supplement below A, but on a smaller scale.

Genotype, *Aëroplana mirabilis*, n.sp. (Upper Triassic, Ipswich, Q.).

AEROPLANA MIRABILIS, n.sp. (Plates xlv.-xlv., Text-figs. 14, 15).

Total length of fossil as preserved, from base of hindwing to end of isolated piece of forewing, 41.5 mm. Total length of preserved portion of hindwing, 26 mm.; greatest breadth of same, 5 mm.

The insect lies upon the somewhat uneven surface of a dark grey shale, in such a position that it is crushed down somewhat dorso-laterally, the hindwing apparently covering the thorax, and having its costal margin passing under the posterior border of the forewing. This latter wing, however, lies at a slightly higher level; so that, in the process of delamination, its posterior border was lifted off, exposing the whole basal portion of the costal



Text-fig 14.

Aëroplana mirabilis, n.g. et sp., (Triassic, Ipswich, Q.). Sketch of the whole fossil *in situ*, ($\times 2$) to show the relative positions of the different parts. A, A, principal portions of the fore- and hindwings, figured in Plate xlv., fig. 12; B, distal portion of forewing, figured in Text-fig. 15. To the left of the wings are shown the crushed portions of the head and thorax. The fossil remains are left unshaded, the rock itself is lightly shaded, and the deep break between the parts A and B is shown in black. The rock around B has been partly cut away with a penknife.

margin of the hindwing. Around the bases of the wings there are scattered a number of chitinous pieces, some belonging to the head, and some to the thorax of the insect. These are so much crushed that they cannot be recognised with certainty; but there are two very concave impressions close together, one circular and the other an irregular oval, which may represent portions of the compound eyes. Below the hindwing, there are two narrow elongated fragments, one about 14 mm. long, the other about

11 mm., which appear to represent the broken-off costal borders of the other pair of wings.

Mr. Dunstan tells me that, in the search for this fossil, the rock broke transversely across the two wings, leaving a considerable gap between them. On the other side of this break, Mr. Dunstan prospected with his penknife, and was fortunate in picking up a further (more distal) portion of the forewing, lying exactly in line with the more basal portion. This part was glued into position on cardboard with the rest of the fossil, as shown in Text-fig.14. Mr. Dunstan assures me that this part is not, at the most, more than a sixteenth of an inch out. If that be so, as it certainly would appear to be from the shape of the wing, then it is clear that the wings of this insect were excessively long and narrow, being in shape not unlike the planes of a modern *aéroplane*. This character suggested to me the name of the genus.

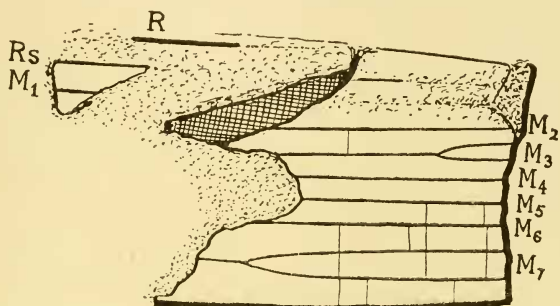
The general character of the wings of the fossil can be well seen from Plate xlv., fig.12. The hindwing is very complete as regards its basal portion, and exhibits a large number of interesting characters. We may most profitably study this wing first.

The costal space appears to be strongly convex, and was probably formed of very hard chitin, since the few cross-veins in it are indistinct, and the whole area appears to have been coriaceous in texture. The convex curvature of this area ends posteriorly in the deep groove of the subcosta, behind which the radius rises strongly up again as a convex vein. The two separate bases of Rs are both strongly marked veins, but the base of the media appears as a very weak vein diverging from R. The bases of Cu and A are strong veins.

In the whole of the basal region of the wing, up to a level just beyond the second origin of Rs, the cross-veins are strongly marked and easily followed. The meshwork here is of a typical Palæodictyopterous type, the cells formed being very irregular in shape. The development of the recurrent supplements between M and Cu, and again between A and the posterior border, in the

hindwing, are clearly interesting attempts to strengthen the wing in the region of greatest curvature of the main veins.

Beyond the level of the origin of Rs, the cross-veins become weaker, and are difficult to make out. In the figure in Plate xlv., I have indicated every possible cross-vein of which I can find traces, by examination in lights of different directions and intensities. Some of these may not be true cross-veins, while there may be others present which I have missed.



Text-fig. 15.

Äroplana mirabilis, n.g. et sp., (Triassic, Ipswich, Q.). Distal portion of forewing beyond the transverse fracture of the rock shown in Text-fig. 14; ($\times 7\frac{1}{2}$).

The preserved part of the forewing is very similar to the hind, except for the different manner of branching of the media, which has been already mentioned. Careful measurements of corresponding portions of fore- and hindwings show that their widths are almost the same, the forewing being slightly wider than the hind, as judged by the perpendicular distance between Rs and Cu_1 . But this may have been offset by a somewhat wider anal area in the hindwing.

The isolated distal portion of the forewing is shown in Text-fig. 15. The main veins are well-preserved, yet there are few indications of cross-veins. It seems probable that the cross-veins became weaker and weaker towards the distal end of the wing, and finally became obsolescent near the tip, so that most of them are not preserved in the fossil. It will be seen that there are

two bifurcations in this distal part of the wing; these have to be taken into account in the restoration of the fossil, which I have attempted below.

Type, Specimen No. 126a. (Coll. Queensland Geological Survey).

Horizon: Upper Triassic, Ipswich, Q.

Restoration of the Wings of Aëroplana mirabilis, n.sp.

(Plate xlv., figs. 13-14).

In attempting to restore the complete wings of this remarkable fossil, I have made two assumptions which appear to be fairly well justified, viz., that the shape and venation of the fore- and hindwings were approximately the same (with the principal differences preserved to us in the fossil as it stands), and that the isolated portion of the forewing, shown in Text-fig. 15, lay close to the apex of the wing.

Even with this latter proviso accepted, and taking full advantage of the possibility of an error of one-sixteenth of an inch in Mr. Dunstan's placing of this fragment, it will be apparent that the length of the wings, in comparison with their breadth, is enormous, the ratio being approximately 7 : 1.

In filling in the gap between the basal half of the forewing and the distal preserved portion, it is necessary to bear in mind the possibility of one or more veins having reached the costal or posterior border, respectively, in the interval. To determine this, I examined the veins in the distal fragment carefully, with the result that I found the uppermost to be more strongly built than the others. This should, therefore, be the radius, as is also evident from its level on the wing itself. Hence, if we assume that there have been no other dichotomies of veins in the missing part of the wing, the veins below R in this part of the wing must be, in consecutive order, Rs and the seven branches of M. Of these last, it will be seen that M₃ and M₇ branch again. There remain, then, as veins that have reached the posterior border of the wing before this level, the two branches of Cu, and A.*

* This interpretation assumes no further dichotomies of M in the missing portion of the wing.

On the above suppositions, we may restore the two wings as shown in Plate xlv., figs. 13-14, the missing portion of each wing being made approximately the same as the corresponding portion present in the other.

The total length of the wings, as restored above, would be about 46 mm. each. If, then, the insect were of slender build, with a narrow thorax, the total expanse of the wings must have been about 96 mm., or nearly four inches. This is very small for a Protodonate; but the fossil bears the marks of a reduced type.

Affinities of the Fossil.

This fossil is certainly one of the most puzzling of all the Ipswich Insects. As far as I know, there is nothing in the whole range of insect-venation, either fossil or recent, that shows any close relationship to it. In finally determining to place it in a new Suborder within the Protodonata, the following points have weighed with me:

(1). The differences in the branchings of the media, in the two wings preserved, are sufficient proof that we have a fore- and a hindwing preserved, not two forewings or two hindwings.

(2). Which wing is the fore and which is the hind, is not capable of absolute proof. But, unless the insect is altogether twisted out of shape, the more anterior one should be the forewing, as I have assumed it to be.

(3). The close similarity evident between fore- and hindwing in venation, as well as in shape, puts several Orders out of court at once; notably the Orthoptera, the Perlaria, and the Homoptera.*

(4). In considering the type of venation exhibited, there would appear to be characters belonging to three Orders, viz., the Protodonata, Planipennia, and Mecoptera. These characters had to be carefully weighed, with reference to known types of each Order.

* We might note here the existence, in Australia, of Homoptera belonging to the subfamily *Derbinae* of the family *Fulgoridae*, with the forewing narrowly elongate as in *Aëroplana*; also, a similar elongation occurs in both wings in the genus *Stenobiella* of the family *Trichomatidae*, in the Order Planipennia.

(5). In the above comparison, due allowance must be made for reduction of the original venation, owing to the extreme narrowing of the wing.

Taking, then, the Mecopteran characters first, it will be seen that these may be practically summed up in the dichotomous nature of the branchings of the media. But, in the Mecoptera, the radial sector undergoes a similar series of dichotomous branchings. We must assume, then, that this type of branching is not in itself evidence of Mecopteran affinities, unless accompanied by other definite characters. That this is certainly so is shown by the archaic *Psychopsis illidgei*, which belongs to the Planipennia, but which has, nevertheless, a media dichotomously branched, in a manner not unlike that of the fossil.

The Planipennian affinities suggested are the general appearance of the wings as being those of a "lacewing," with their numerous parallel longitudinal veins supported by, for the most part, delicately formed cross-veins; the great strength of the radius, and the close, parallel situation of the subcosta in a deep groove in front of it; and also the correspondence between the branchings of M in the fossil and in *Psychopsis illidgei*, already mentioned.

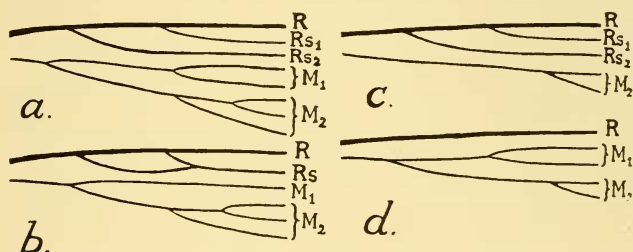
The principal characteristic of all known Planipennia, however, is the large number of descending branches of the radial sector. It is these veins that form, in this Order, the majority of the parallel longitudinal or oblique veins traversing the wing. But, in the fossil, Rs is unbranched. This alone seems quite sufficient to prevent us placing the fossil within the Planipennia. Further, in all archaic Planipennia, the series of cross-veins between C and Sc is oblique; whereas, in the fossil, those that can be seen are at right angles to the main veins, as in Odonata and Protodonata.

A further argument against both Mecopteran and Planipennian affinities for this fossil is the absence of any signs of *macrotrichia* upon the main veins. Even the strongly built radius, which is exceptionally well preserved, shows no signs whatever of having carried these structures.

The Odonata themselves cannot be brought into consideration,

since the fossil evidently lacks the essential discoidal cell, not to mention a nodus, which is almost certainly absent also. We are therefore driven back to consider the claims of the Protodonata.

The strongly built, probably coriaceous, border is already known in the Carboniferous genus *Meganeura*. The new fossil also resembles this genus in the manner in which M appears basally as a very weak vein diverging gently from the strongly built R. The Protodonata, like the Odonata, are notable for the unbranched condition of Rs. Now, in *Meganeura*, there are, in the forewing, two radial sectors arising fairly close together, and running closely parallel for a considerable distance. If, owing to the narrowing of the wing, in the course of evolution,

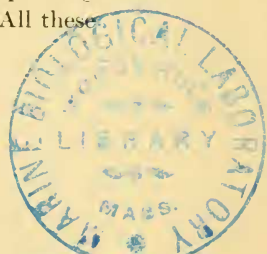


Text-fig. 16.

Diagrams to show the structure of the radius and media in Protodonata:

a, suggested ancestral condition, from which there can be derived:—*b*, the condition found in *Aëroplana mirabilis*, n.g. et sp., by fusion of the two radial sectors (Rs_1 , Rs_2) near their bases; *c*, the condition found in the forewing of *Meganeura monyi* Brongn., with radial sectors still separate, but anterior branch of media (M_1) eliminated; and *d*, the condition in the hindwing of the same species, with the radial sectors eliminated but the media not reduced.

these two sectors were to fuse together, we might expect to get some such formation as we find in this new fossil, viz., a single Rs with two origins. In the hindwing of *Meganeura*, however, we find that Rs is entirely absent. But there is a peculiar anterior branch of M, which takes its place, and which branches dichotomously exactly in the same way that the corresponding branch of M in the hindwing of the new fossil does. All these



conditions, viz., that in the forewing of *Meganeura*, that in the hindwing of the same genus, and that in the hindwing of *Aëroplana*, can be easily obtained by reduction from the type of venation shown in Text-fig. 16, *a*, as may be seen from *b*, *c*, and *d* of the same Text-figure.

The rest of the media in *Meganeura* differs widely from that of *Aëroplana*, as is only to be expected when one considers the difference in the shape of the wings.

The cubitus in *Meganeura* (and probably in other Protodonata so far known) is simple. But it is a sinuously curved vein, resembling the Cu_2 of *Aëroplana* in its general course basally. Both genera have only a single main anal vein. But in *Meganeura*, as in other Protodonata, both Cu and A give off numerous descending branches, which are absent from *Aëroplana*.

We can only conclude that there is a certain amount of evidence of affinity between *Meganeura* and *Aëroplana*, though that evidence is by no means strong. The numerous points of difference are so evident that it will scarcely be necessary to enumerate them. There are, then, only two courses open to us: either we must place *Aëroplana* in the Order Protodonata, as a very highly specialised member, far removed from any known type of that Order; or we must make a new Order for it. In choosing the former alternative, while at the same time emphasising the unique character of the new fossil by placing it in a new Suborder, Aëroplanoptera, I have taken a course which will serve to indicate the degree of affinity of the fossil to the rest of the known Protodonata, while leaving it open to any other entomologist, if he considers this affinity insufficiently established, to raise the new Suborder to the status of an Order.

In conclusion, it seems to me quite possible that this extraordinary fossil may have held much the same position in the Order Protodonata, with respect to the *Meganeuridae*, that the advanced *Agrionidae* hold to-day, within the Order Odonata, with respect to such gigantic, archaic types as *Petalura*. If that be so, its existence in the Upper Triassic—at a time when, it is to be presumed, the rest of the Order had died out—need

occasion us no surprise, but is rather to be expected; just as we may expect that the more advanced Dragonflies of to-day will remain in existence, long after *Petalura* has become extinct.

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EXPLANATION OF PLATES XLIV.-XLV.

Plate xliv.

Fig.12.—*Äeroplana mirabilis*, n.g. et sp. Principal preserved portions of the wings; ($\times 7$).

Plate xlv.

Figs.13-14.—*Äeroplana mirabilis*, n.g. et sp. Restoration of fore- and hindwings; ($\times 4$). Fig.13, forewing; fig.14, hindwing.

1A, analis; C, costa; Cu₁, Cu₂, the two branches of the cubitus; M₁-M₇, the seven principal branches of the media; R₁, main stem of radius; Rs, radial sector; Sc, subcosta.

POSTSCRIPT (*added July 12th, 1918*).—The following important changes of nomenclature have to be made:—

Mesopanorpa Tillyard, 1918 (Type, *M. wianamattensis* Tillyard, Upper Triassic of Glenlee, N.S.W., Mecoptera,) becomes *Mesopanorpodes*, n.n.; preoccupied by *Mesopanorpa* Handlirsch,

1908 (Type, *M. hartungi* Brauer, Redtenb. & Ganglb., Middle Jurassic of Ust Balei, Siberia). The family *Mesopanorpidæ* Tillyard becomes the family *Mesopanorpodidæ*, n.n. (See Tillyard, These Proceedings, 1917, xlii., Pt.4 (1918), pp.746-7).

Creagris Hagen, 1860 (Type, *C. plumbeus* Oliv., Neuroptera Planipennia, Europe) becomes *Creoleon*, n.n.; preoccupied by *Creagris* Nietner, 1857, a genus of Coleoptera, Fam. *Carabidæ*. I am indebted to Mr. T. G. Sloane for this discovery. (See Tillyard, These Proceedings, 1918, xliii., Pt.1, p.122). The tribe *Creagrini* becomes the tribe *Creoleontini*, n.n.—R.J.T.

POSTSCRIPT (added August 7th, 1918).—The title of Part ii. of this series of Studies should be amended as follows:—

For "*Eschnidiopsis* (*Eschna*) *hindensiensis* (Woodward)", write "*Eschnidiopsis hindensiensis* (Woodward), [*Eschna*]." It was never intended to convey the suggestion that *Eschna* is a subgenus of *Eschnidiopsis*, and hence the order of the names must be altered as here shown.—R.J.T.